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Janolus rebeccae, a new species of arminacean nudibranchs from northern Chile

(Gastropoda, Nudibranchia, Zephyrinidae)

By **Michael Schrödl**

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The specimens previously reported from northern Chile as "*Janolus* sp. 1" by Schrödl (1996), in this study are described anatomically and histologically, and briefly compared with other known species of the genus *Janolus* Bergh, 1884. The species studied comes closest to the Californian *J. barbarensis* (Cooper, 1863). Due to several external, digestive and reproductive features differing in details from those of *J. barbarensis*, the Chilean species is considered to be new; it is described under the name *Janolus rebeccae*, spec. nov.

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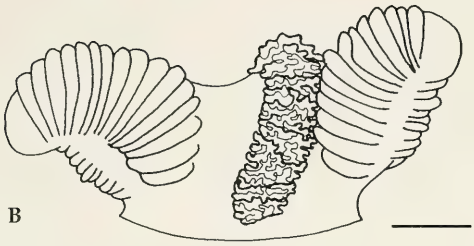
Introduction

The genus *Janolus* Bergh, 1884 comprises a group of remarkable nudibranchs: Externally the relatively large individuals are characterized by the presence of numerous elongated dorsal appendages (cerata) which are often brightly coloured, giving them an aeolidacean-like appearance. However, the presence of an undulating crest (caruncle) between the perfoliated rhinophores distinguishes all *Janolus* species externally from aeolidacean nudibranchs.

Revising the South African Janolidae, Gosliner (1981) fused the genus *Antiopella* Hoyle, 1902 with the senior *Janolus*, described *J. longidentus* Gosliner, 1981 and compared the species belonging to *Janolus* known at that time. Subsequently, Gosliner (1982) redescribed the Californian *J. barbarensis* (Cooper, 1863) and reinstated *J. fuscus* O'Donoghue, 1924, which previously often had been confused with the former species. In a comprehensive account on New Zealand arminaceans Miller & Willan (1986) suggested that the family group name Zephyrinidae Iredayle & O'Donoghue, 1923 should replace the also commonly used junior synonym Janolidae Pruvot-Fol, 1954. They redescribed in detail the poorly known *J. novozealandicus* (Eliot, 1907) and showed that *J. flagellatus* Eliot, 1906 is conspecific with *J. hyalinus* (Alder & Hancock, 1854). *Bonisa nakaza* Gosliner, 1981 was considered to belong to *Janolus*, synonymizing the monotypic genus *Bonisa* Gosliner, 1981 with the senior *Janolus*. Together with three new species described by Miller and Willan (1986) the genus *Janolus* is comprised of 18 species distributed worldwide within temperate and warmer waters. However, from the southeastern Pacific just recently a single species ("*Janolus* sp. 1") has been reported and briefly described externally (Schrödl 1996). In the present study, this Chilean species is described anatomically and compared with other species of the genus *Janolus*.

A



B

Fig. 1. *Janolus rebeccae*, external features. A. Dorsal view of the living holotype. Scale bar: 5 mm. B. Rhinophores and caruncle of the preserved paratype. Scale bar: 0.5 mm.

Methods

All specimens have been collected using SCUBA. After observing the specimens in situ and in aquaria they were narcotized with a 10 % $MgCl_2$ solution and preserved in 70 % ethanol. All specimens were partly dissected macroscopically. Some cerata, the rhinophores together with the caruncle, and parts of the genital system were removed from the paratype, postfixed with formalin and embedded in Hydroxyethylmethacrylate for serial sectioning. The 2.5 µm sections were stained with toluidine blue and histologically examined. SEM examinations of jaws and radulae were made using a Philipps XL 20 Scanning Electron Microscope.

Janolus rebeccae, spec. nov.

Types. Holotype: 1 dissected specimen collected by M. Schrödl on 16 March 1994; Bahía Inglesa (27°07'S, 70°53'W), at 3 m depth, on *Bugula flabellata* (Thompson)(Zoologische Staatssammlung München ZSM, No. 19960557). - Paratype: 1 dissected specimen, collected by M. Schrödl together with the holotype (Museo Zoológico de la Universidad de Concepción, Chile, No. 24048). - Additional material: 1 juvenile specimen, dissected, collected by M. Schrödl on 26 February 1994, Juan López (23°30'S, 70°32'W), at 12 m depth, on algae.

Tab. 1. *Janolus rebeccae*, body dimensions, jaw and radular characters of specimens examined.

Specimen No.	Body length (mm) (alive/preserved)	No. of jaw denticles	Radula formula (No. of rows × No. of teeth per row)
1 (holotype)	43/23	10-12	26 × 30.1.30
2 (paratype)	20/ 8	10-11	20 × 26.1.26
3	12/ 5	10-11	22 × 25.1.25

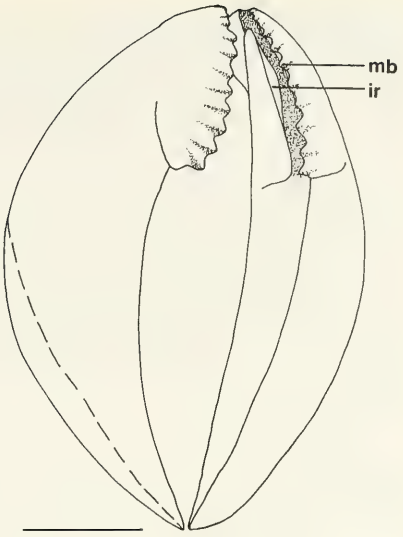


Fig. 2. *Janolus rebeccae*, specimen No. 3. Drawing of the jaws. Note denticulate masticatory border (mb) and smooth inner ridge (ir). Scale bar: 0.5 mm.

Description

External morphology. The crawling holotype reached 43 mm in length. Body dimensions are given in tab. 1. Body shape elongate, anterior border of head rounded. Numerous cerata present all around the notal margin and arranged in irregular transverse rows. Middorsal region and tail do not bear cerata. Cerata smooth, longish, considerably inflated and bear an elongated slender tip. Generally cerata length increases from margin towards centre, the innermost cerata being the longest ones. However, the holotype bears several very small inner cerata, which may substitute lost longer ones. Diverticles of the digestive gland project into all cerata, begin to branch irregularily one to several times within the first half of the cerata, and nearly reach their tips. The cerata may be easily autotomized by the specimens during rough handling.

Rhinophores large and perfoliated. Only the most basal parts smooth; these cannot be distinctively separated from the notum. Between the rhinophores a median ondulating crest, the caruncle (Fig. 1B). The head bears two short oral tentacles lateral to mouth opening. Anteriorly the foot is deeply grooved into two lips, laterally the foot corners protrude considerably. Upper lip notched in middle and connected with the tissue surrounding the mouth opening. Anus situated far posteriorly, slightly to the right of middorsal line. Gonopores open laterally just below notum, slightly in anterior half of the preserved holotype.

Colour. Body as well as caruncle translucent. Tail with median opaque white line, on notum some scattered opaque white dots may be present. Cerata with a subapical golden brown ring and white tips. Rhinophores also have white tips above a subapical light blue marking. The dark brown content of the digestive glands' branches visible through the notum and within the cerata. Also the whitish anal gland shines through the notum.

Digestive system. A ring of small subepidermal mouth glands present. There is a pair of strong, cuticularized jaws; the masticatory borders of the two smaller specimens (No.'s 2 and 3) bear 10 to 11 denticles each; the damaged masticatory borders of the holotype may bear 10-12 denticles. Posterior to the denticulate masticatory border is a second, less elevated and smooth ridge (Fig. 2).

Radulae with up to 26 rows (Tab. 1). Rhachidian teeth hook shaped; a slender basal plate bears a more or less elongated, rather broad and blunt median cusp without lateral denticulation (Fig. 3). Lateral teeth simply hook shaped without denticles, they increase in size towards middle of half row; the outermost teeth small.

A pair of flat dendritic salivary glands lie adjacent to the roomy, transversely extending stomach. As described for *J. capensis* by Gosliner (1981), in the present material there are three major branches of the

Fig. 3. *Janolus rebeccae*, SEM photograph of rhachidian and inner lateral radular teeth of the holotype. Scale bar: 0.01 mm. Abbreviations: r: rhachidian tooth, l: first lateral tooth.

digestive gland leaving the stomach; the first leaves the stomach anteriorly to the left entering the anterior left cerata, the second inserts the stomach on the left side and runs to the posterior left and right cerata. The third branch leaves the stomach laterally on the right side and its diverticles insert into the anterior right cerata. Macroscopically, the terminal regions of the diverticles do not appear to differ from the usual digestive gland structure. The stained sections show that the apices of the diverticles are characterized by an accumulation of large, optically empty cells, whereas further basally there are smaller digestive gland cells which are filled with blue staining granules (Fig. 6). The intestine extends far posteriorly and opens through an elevated anal papilla. A large anal gland surrounds the anus.

Reproductive system. Generally the reproductive organs of all three specimens are very similar in shape, with exception of the smaller size of the female gland mass of the small, not fully developed specimen (No. 3). Figure 4 gives an outline of the reproductive organs of specimen No. 2. In all specimens the hermaphroditic duct inserts into a spherical ampulla. Nearly opposite to the insertion the distal gonoduct leaves the ampulla, but bifurcates readily into a thick vas deferens and a thinner oviduct. After a few convolutions the vas deferens passes into a thick and conical penial papilla which is covered by the muscular wall of the male atrium. The penial papilla is not armed by a cuticle.

Distally the thin proximal oviduct becomes considerably thicker and bulbous. In specimens No. 2 and 3 this bulbous oviduct portion is additionally curved, forming a knobby organ, just before the insertion of the stalked, elongate receptaculum seminis. The female glands insert distally at the oviduct next to the female aperture. No separate bursa copulatrix was detected. This genital system represents an androdiaulic condition type II according to Schmekel (1970).

The following histological results refer to the serially sectioned genital system of the paratype: The ampulla is filled with autosperms. The vas deferens is prostatic throughout its length. The vas deferens wall consists of an inner layer of glandular cells containing large, unstained vesicles which is surrounded by an outer muscular layer. Distally the thin proximal oviduct becomes wider and longitudinally folded. Within this externally bulbous portion, the inner structure resembles that of the stalked receptaculum seminis: The inner epithelium is strongly folded, bears dense and long cilia and is covered by well developed muscular layers. Distally from the insertion of the stalked receptaculum seminis the inner structure of the oviduct changes. Its wall becomes less folded, the epithelial cells bear

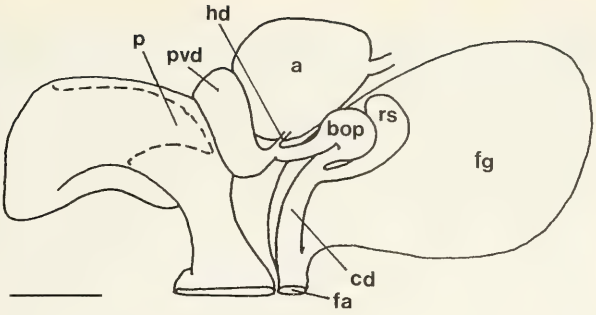


Fig. 4. *Janolus rebeccae*, outline of the genital system of the paratype. Scale bar: 0.5 mm. Abbreviations: a: ampulla; bop: bulbous oviduct portion; cd: oviduct; fa: female aperture; fg: female glands; hd: hermaphroditic duct; p: penial papilla; pvd: prostatic vas deferens; rs: receptaculum seminis.

much shorter cilia and there are fewer muscles. As this portion of the oviduct do not show the thin walled and glandular structure of a usual doridacean bursa copulatrix, a gametolytic function is not likely. The female gland complex and the distal vagina could not be examined histologically due to damage during previous macroscopical examination.

Central nervous system. In the holotype the cerebral ganglia are completely fused with the pleural ganglia (Fig. 5), in specimen No. 2 a superficial notch is still visible. The buccal ganglia are well separated from each other. Anteriorly each cerebral ganglion may bear two nerves inserting very close together, or only one nerv which bifurcates basally; the outer branches insert into the rhinophoral ganglia which are situated basally within the rhinophores, both inner branches innervate the caruncle. Due to the cerebral innervation from both sides (Fig. 5) and to histological results showing a similar, ciliary structure of the rhinophoral and caruncle tissue (Fig. 7), the caruncle of *J. rebeccae* probably is a paired, fused sensory organ, which may be a descendent of the janolid rhinophores. The eye nerves of the holotype are long, those of specimen No. 2 are somewhat shorter; basally there are distinct optical ganglia. A statocyst with several otoconia nestles between pedal and cerebropleural ganglia.

Ecology and distribution. All three specimens were found in the rocky upper subtidal between 3 and 12 m depth during February to March 1994. Two specimens from Bahía Inglesa were observed in situ and later in the aquarium to feed on the arborescent bryozoan *Bugula flabellata* (Thompson). The known geographical distribution of *Janolus rebeccae* ranges from Bahía Inglesa (27°07'S, 70°53'W) north to Juan López (23°30'S, 70°32'W) (Schrödl 1996).

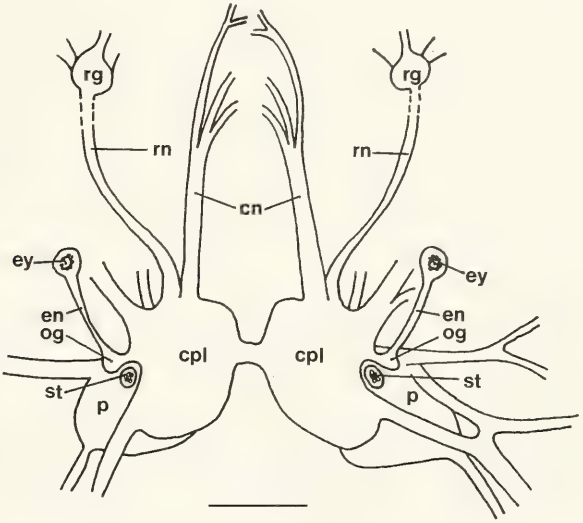


Fig. 5. *Janolus rebeccae*, central nervous system of the holotype. Ventral parts of the central nervous system and esophagus are omitted. Scale bar: 0.5 mm. Abbreviations: cn: caruncle nerves; cpl: fused cerebropleural ganglia; ey: eyes; en: eye nerves; og: optical ganglia; p: pedal ganglia; rg: rhinophoral ganglia; rn: rhinophoral nerves; st: statocyst.

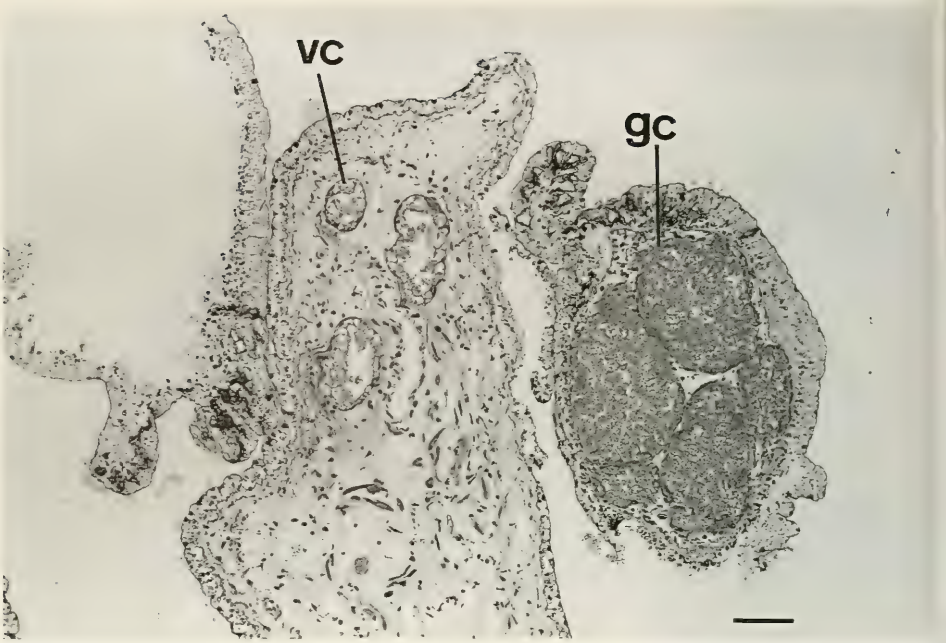


Fig. 6. *Janolus rebeccae*, paratype. Histological section of cerata containing digestive gland diverticles. Terminal portion of diverticles containing predominately large vacuolized epithelial cells (vc). More basal portion mainly with smaller, grana containing cells (gc). Scale bar: 0.1 mm.

Discussion

Despite their different sizes, the specimens described above are rather uniform regarding colour pattern, body shape and internal features; the smallest individual is an exception in that it has a still poorly developed female gland mass. In consequence, there is no doubt that they are conspecific. Due to external features like general body shape, possession of cerata and caruncle, they can be assigned to the genus *Janolus*. Within this genus, species can be divided into two groups: (1) Eight species having denticulate mandibules formerly assigned to a separate genus *Antiopella*. *J. novozealandicus* Eliot, 1906 which originally was reported to have an irregular denticulation on its masticatory jaw edge (Eliot 1906) was redescribed as having a smooth edge (Miller & Willan 1986). (2) Species lacking any jaw denticles (10 species including *J. novozealandicus*). Since the Chilean species studied here has well developed jaw denticles (Fig. 2) it has to be compared taxonomically with the species belonging to the first group: According to Gosliner (1981, 1982) the northeastern Pacific *J. fuscus* has unbranched ceratal ducts whereas these are branched in the present species. *J. longidentatus* from South Africa differs due to its denticulate rhachidian teeth (Gosliner 1981) from the present species with its smooth rhachidians. Marcus (1958) described a Brasilian species, *J. mucloc* Marcus, 1958, as having a triaulic genital system. The same condition was mentioned for the Japanese *J. toyamensis* Baba and Abe, 1970 by Gosliner (1981), which clearly separates both these species from the diaulic Chilean species. The latter mainly agrees with the European *J. cristatus* (Delle Chiaje, 1841) regarding mandibular and reproductive features even if a small distal allosperm vesicle mentioned for *J. cristatus* could not be detected in the material examined. However, *J. cristatus* described and figured by Schmekel & Portmann (1984) is distinct from the Chilean species due to colour pattern and digestive diverticula which branch at the ceratal apices in *J. cristatus* and not already in the basal half of the cerata as in the Chilean species. The latter possesses a stalked receptaculum seminis, together with an additional receptacle-like bulbous oviduct, whereas the Californian *J. barbarensis* has a single serial receptaculum seminis (Gosliner 1982).

Fig. 7. *Janolus rebeccae*, paratype. Histological section of rhinophores (rh) and caruncle (ca) showing their similar structure. Scale bar: 0.1 mm.

J. indicus (Eliot, 1909) and the Atlantic *J. praeclarus* Bouchet, 1975 are incompletely described. Due to their body colouration which is translucent with red-brown spots (Eliot 1909) and orange with opaque white (Bouchet 1975), respectively, they differ from the here described species which has a translucent body with only few white spots on the notum.

In its external appearance the Chilean species most resembles the Californian species *J. barbarensis* as it has been redescribed by Gosliner (1982) and pictured in Behrens' (1991) guide to "Pacific Coast Nudibranchs". Previous descriptions of *J. barbarensis*, e.g. by MacFarland (1966), have been shown to confuse data from both Californian species, *J. barbarensis* and *J. fuscus* by Gosliner (1982), and therefore they are not used for the following comparision: Within the Chilean material the rhinophores lack the lemon yellowish colouration described for *J. barbarensis*, and, as well as the cerata, they have white tips, instead of the light to dark blue tips in *J. barbarensis*. The caruncle is transparent, not orange as in *J. barbarensis*. A median white line is exclusively present on the tails of the Chilean specimens. The brownish branchings of the digestive glands are visible through the notum dorsally and within the cerata; in *J. barbarensis* the ducts of the digestive glands are only visible within the cerata, but not through the notum.

The Chilean species, even the smallest individual, possesses more mandibular denticles than *J. barbarensis* (10-12 vs. 7-9). Posteriorly to the denticulate masticatory border there is a second, smooth but clearly elevated ridge (Fig. 2) which is not mentioned to be present in *J. barbarensis*. The rhachidian teeth of the Chilean species are hook-shaped without bearing denticles, and have a slender base. The lateral teeth do not possess denticles. In contrast, *J. barbarensis* has rhachidians with a broad base and inner laterals which Gosliner (1982) described to possess up to six irregular denticles.

In the Chilean specimens the cerebropleural ganglia may be completely fused (holotype), or superficially notched (paratype) as it was described for *J. barbarensis*. Also the length of the optical nerves varies within the Chilean material studied: The holotype has optical nerves nearly as long as drawn for *J. longidentatus* by Gosliner (1981), whereas they are only about half as long in the paratype. Gosliner (1982) described *J. barbarensis* as having "much shorter" optical nerves than *J. longidentatus*. Regarding

reproductive characters there are several differences: The ampulla is saccate or slightly convoluted in *J. barbarensis* but rounded in the Chilean species. Both species possess a large and thick glans penis and an externally similar, thick and rather short vas deferens. This duct is described to be muscular and not prostatic in *J. barbarensis* by Gosliner (1982), but is prostatic throughout in the Chilean species, possessing just a superficial muscular layer. As mentioned above, the most conspicious difference between the Chilean species and *J. barbarensis* appears to be the presence and position of the allosperm vesicles within the female genital system: The former possesses a stalked longish receptaculum seminis and, additionally, has a bulbous oviduct portion which, due to its similar structure, possibly also serves as an allosperm receptacle; the distal oviduct has no gametolytic function, a separate bursa copulatrix could not be detected. In contrast, *J. barbarensis* is described to have a large rounded bursa copulatrix entering the female vestibule opposite to the oviduct insertion; the receptaculum seminis is serial. According to Gosliner (1982), the vagina may or may not bear a thin additional duct which separately enters into the receptaculum seminis. This structure variability, as well as the low number of examined specimens of both, *J. barbarensis* and the Chilean species, are reasons against stressing these apparentely clear genital differences for a specific separation. Technical problems dissecting the compact female organs may lead to misinterpretations, and it is difficult to judge on the prostatic (or not prostatic) character of the vas deferens without a histological examination. However, additionally considering the numerous external, mandibular and radular differences, a specific separation between the Californian and the Chilean species appears to be indicated. Thus, in the present study, the Chilean species is established as a new species.

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The name of the new species acknowledges the constant help and understanding of the author's wife Rebecca Schrödl as well as her instinctive feeling that this beautiful species may be new.

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